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ORI INC SILVER SPRING MD

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DEVELOPMENT OF SPECIAL PURPOSE COMPUTERS - ADVANCED NARROWBAND --ETC(U)

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Attn: Code 7520, John Ihnat

Subj: Final Report

Ref: Contract No. N00173-80-C-0087 *KCJ*

Encl: Development of Special Purpose Computers - ANDVT Breadboard -
Final Report

Gentlemen:

As required by CDRL A002 of the referenced contract, enclosed are three (3) copies of the final report of this contract effort. This report summarizes the support provided under each of the task areas of the contract.

ORI has enjoyed the experience of working with the staff of Code 7520 and being associated with the ANDVT Program. As future work areas are identified, ORI would like to be considered as a capable technical resource for NRL to draw upon.

Very truly yours,

REAL-TIME SOFTWARE APPLICATIONS DIVISION

RJ Heck

R. J. Heck
Program Director

Enclosure (3)

cc: NAVELEX, Code 3103 (3 copies)
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DEVELOPMENT OF SPECIAL PURPOSE
COMPUTERS - ADVANCED NARROWBAND DIGITAL
VOICE TERMINAL BREADBOARD.

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Final Report.

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Prepared Under N00173-80-C-0087

For the

Naval Research Laboratory
4555 Overlook Avenue, S.W.
Washington, DC 20735

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1.0 INTRODUCTION

This document summarizes the software development provided to the Naval Research Laboratory by ORI, Inc., under Contract No. N00173-80-C-0087. The objectives of this contract were the development of software for the signal processing computers and interface processors for the Advanced Narrowband Digital Voice Terminal (ANDVT) Breadboard, and to provide the system generation and software development of an Interactive Laboratory System (ILS).

2.0 HF MODEM SUPPORT

Support for the HF modem was provided through modification and testing of the transmitter and receiver programs to provide compliance with the ANDVT specification and compatibility with the Fortran HF modem program. Initial support in this area was provided by ORI and was continued by this contract.

2.1 Receiver Program

Under the previous contract major changes were made to the RAID program, which provides the scheduling of the input/output and the processing routines, and preliminary modifications were made to the receiver executive to make it compatible with the new RAID program. This effort continued in this contract and the net voice, data, and SARK mode portions of the receiver were added, as well as narrowband doppler acquisition and frame synchronization routines.

Doppler correction capabilities were enhanced in the narrowband acquisition and tracking areas. Narrowband doppler acquisition was added to the receiver to allow correction of small doppler offsets as well as providing fine adjustment of the wideband doppler correction factor. Problems with the doppler tracker were eliminated by separating the preamble correction from the tracking factor, thus eliminating ringing of the tracking filter due to large

initial input data. Adjustment of the gain and feedback parameters of the tracking filter then enabled accurate tracking of drifts up to 3.5 Hz/sec and offsets of up to 200 Hz.

Thresholds used for signal presence detection for the various parts of the preamble were changed to correspond to the ANDVT specification. Signal presence tests were also enhanced by adding logic which tests for the biphasic modulation used during the epoch transmission.

The Golay decoder used in the receiver was changed to use the correct polynomial after it was discovered that the modem used an alternate Golay coding scheme.

The data mode was found to perform the de-interleaving incorrectly and was modified to be compatible with the specification.

The final status of the receiver program is that net voice and data modes have been implemented and tested satisfactorily. SARK mode has been implemented and testing has begun but is not complete.

2.2 Transmitter Program

The executive for the modem transmitter program was rewritten to make it compatible with the new RAID program. Major changes were required in the input/output routines but other changes were required to correct errors in the previous implementation. The dummy frames transmitted during net voice mode were found to be of the wrong frame length and were corrected to meet the ANDVT specification. The Golay encoder was changed as in the receiver program to use the correct polynomial. The timing of the START signal sent to the BLSI in the data mode was corrected to eliminate a one frame error in filling the interleaver buffer.

The final status of the transmitter program is that net voice and data modes have been implemented and tested satisfactorily. SARK mode has been implemented and testing has begun but is not complete.

2.3 Testing

Use of the breadboard has provided real-time testing capabilities which have been useful in analyzing the performance of other equipment. An error in the tone permutation used in the Fortran modem was discovered when the recorded signal was received by the breadboard modem. The breadboard confirmed the proper operation of the Fortran transmitter after changes were made to the Fortran transmitter to send actual voice data and the synthesized voice was then produced by the breadboard voice processor. Preliminary tests of the ITT implementation of the ANDVT modem pointed out errors in several areas in that version. Performance tests of the modem were done with both simulated channels and actual HF radio equipment.

2.4 Miscellaneous

In order to improve the efficiency of the use of the modem processor and to reduce the burden on the PDP 11/45 host processor, the TRW assembler was rewritten in Pascal. The new assembler is easily modified if required, and provides more useful features than the previous assembler.

3.0 INTERFACE PROCESSORS SUPPORT

The support provided for the Red LSI-11 (RLSI) and the Black LSI-11 (BLSI) completed the design and implementation of the various modes of operation and provided testing capabilities for hardware modifications.

3.1 BLSI Control Program

Implementation and testing of the SARK, 600 bps, 1200 bps, and 2400 bps data modes has been completed using the modem bypass configuration. A stand-alone Black transmitter program (SABTX) was written to provide timing and handshake signals so that the modem processors were not required for the debugging of the various data modes (the modem processors only implement the 300 bps data mode). Timing of the handshake signals with the modem processor when in the normal operating mode were adjusted to correspond to the new versions of the modem programs.

Detection and debugging of hardware problems in several areas were accomplished through the BLSI program. Modifications to the hardware in the CM interface and corresponding changes to the software were tested and verified. An error in the clocking of the CM was discovered resulting in the necessity of a hardware modification.

A breakpoint routine was added to aid in the testing and debugging of both the hardware and software.

The final status of the BLSI program is that the net voice and data modes are fully operational in both the normal operating and modem bypass configurations. The higher rate data modes (600, 1200 and 2400 bps) have been implemented and tested in the modem bypass configuration. SARK has been implemented in the modem bypass mode but testing of the normal operation has not been completed pending final testing of the modem programs.

3.2 RLSI Control Program

Implementation and testing of the RLSI program and the CMSIM program, which is implemented in the Red LSI-11 has closely followed the progress in the BLSI program and all the modes which are operational in the BLSI are also operational in the RLSI.

An additional feature was added to the RED program, called the modem test mode, which inhibits the testing and transmission of the LPC sync bits used in the voice processor for synchronization. This allows direct measurement of error rates in the transmission of data using standard modem test sets.

A sync problem in the voice mode due to conflicting interrupts was eliminated by disabling other interrupts during an interrupt which required immediate servicing. A queue overflow condition which caused the occasional loss of the first frame of voice data was corrected. Another correction was made to the data transfer in the 300 bps data mode which caused a duplication of data bytes in the output bit stream. Breakpoint routines were added to RED and CMSIM to aid in the debugging of these programs.

4.0 SYSTEM GENERATION AND ILS SUPPORT

An operating system generation and installation of an Interactive Laboratory System (ILS) were performed and additional features were included to enhance the capabilities of these systems.

4.1 RSX-11M System Generation

The generation of an RSX-11M operating system for a PDP 11/45 host computer was done to provide an operating system in which the ILS software could be run. The necessary verification procedures were completed successfully. A second system generation was done and verified to provide additional dynamic memory allocation to increase efficiency.

4.2 Interactive Laboratory System

ILS versions 2 and 3 were compiled, assembled, linked and verified. Numerous errors in the programs and the documentation were corrected and reported to Signal Technology Inc., the supplier of the ILS software. Additional corrections provided by STI were also incorporated into the ILS.

The ILS software as delivered to NRL had no input/output capabilities. Programs which perform these functions were added to ILS to allow magnetic tape data to be transferred to and from ILS data files. Investigation of an interface design using the LPA-11K data acquisition system was done and recommendations were made to STI. Testing of the LPA software was then performed and showed that the software as delivered was unusable because it was compiled with a different Fortran compiler. Fortran source files for the LPA software which can be compiled under the host operating system were requested from STI. Revised data acquisition software was tested and made operational after errors with the interrupt vector and keyboard interrupt routine were corrected.

Investigation of incorporating the LPC-42 voicing processing program and a minimum cross-entropy spectral analysis program in the ILS was done. An APL minimum cross-entropy spectral analysis program (MCESA) was converted to

Fortran to enable it to be run on the RSX-11M system. Tests of this program showed a convergence problem in some cases due to a loss of significance of data. A double precision version of MCESA was written and all tests showed that the convergence problem had been eliminated. A multiple spectrum version of the MCESA program was written and tested.

ILS commands MCE and MC2 were designed to interface the MCESA program to the ILS, and MCE was tested successfully. A subroutine was written and tested which converts the Lagrange multipliers to autoregressive coefficients to allow interfacing to ILS. Implementation of the MC2 command has begun.

5.0 VOICE PROCESSOR SUPPORT

Voice processing support was provided through the real-time implementation and modification of the LPC-10, noise suppression, automatic gain control, and synthesized sidetone programs.

5.1 LPC-10 Program

Test tapes were made using various smoothing methods in the LPC-10 program to evaluate the performance in the Diagnostic Rhyme Test under error conditions. Timing of the LPC subroutines was performed and the latest version of the LPC program (version 42) was modified to be compatible with the NRL equipment.

5.2 Noise Suppression Program

A test program was written to test the performance of the forward and inverse fast Fourier transform (FFT) and was tested successfully. Another test program was written and tested which performs a 256 point real FFT from a 128 point complex FFT. The FFT and inverse FFT were then incorporated into a real-time implementation of the NRL noise suppression program. This program was tested using helicopter and propeller background noise environments, and documentation of the program was written.

5.3 Automatic Gain Control Program

The automatic gain control program was implemented, and the Diagnostic Rhyme Test was used to evaluate its performance . A new AGC program based on probability distributions was written, tested and verified and tests showed that the voiced/unvoiced decision used in that program were inferior to the LPC decision. The AGC program was added to the LPC program and documented. Tests of the AGC showed that it works well in a 30 dB range.

5.4 Synthesized Sidetone Program

A synthesized sidetone for the LPC program was written and debugging has begun.

5.5 Miscellaneous

Modifications were made to the assembler for the voice processing computer, and a more efficient program for downloading the processors was written and tested successfully.

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